FRBF Neural Network base for Face Recognition using Zernike Moments and PCA

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ABSTRACT
In this paper a method to face recognition in digital images based on statistical features and fuzzy neural networks will be introduced. In order to increase system performance, and analysis of the basic components, Zernike moments used as features have been used and various combinations of these features have been introduced. Work is based on the use of fuzzy neural network of FRBF with a teaching method based on fuzzy training in face recognition with high accuracy. In FHLA algorithm used in learning, in addition to determining weights between hidden layer and output layer parameters, including center RBF neurons and the width shall be determined during the training process. In this way of education, initial values of parameters using fuzzy logic and troubleshooting methods and fuzzy clustering hidden layer neurons are obtained by number of FCM techniques. To determine the final values of communication parameters and weights, the gradient method and the LLS is used as optimization methods. Test results show that this technique has very good accuracy in identifying faces on the database composed of 1000.

Keywords
Component Analysis, Neural Network RBF, Face Recognition, Zernike Moments.

1. INTRODUCTION
The subject of identification has long attracted the engineers and specialists mind as to design intelligent systems that can help them distinguish the identity of persons [1]. The identification uses two types of features: 1 - Indirect features, such as types of passwords that basically "because of the possibility of easy access to people, are poor and has low credits – 2- direct properties, which are properties that depend on physical, mental and emotional people, such as fingerprint [2], signature [3], handwriting [4]. Processing of faces are done with one of the following two targets.

For this purpose, a figure enters the system as input and the system is asked to determine who is the face belongs to. Actually entrance faces belong to one of the existing face classes.

for this purpose, a figure is given as input to the system and is claiming that this is the face belonging to a particular person, now system, compares the reference figures of people during a process of comparison, the figure compares the input and Finally, the figures shall approve or reject, in this way, the important features of the signature shall be compared.

Face processing whether with the aim of identifying or purpose of approving, can be done by the two forms.

- **Inline**: In this way by a number of digital cameras and processing of information extracted from face are done. In this way, dynamic information such as image processing speed, acceleration, size, precision components and face image is extracted. This method is used less.
- **Out of line**: In this method, the image of the face is prepared by a scanner or digital camera to support various features such as pixel statistics, general information and the overall picture and etc, Is being processed [5]. In this way, there is no trace of acceleration, speed and other observed characteristics of inline. Considering that typically face is used on the cards, official documents and records and drawn faces at a time and need to process and identify occurs on the other, processing virtually inline" is not usable and need to identify ways of out- line processing, so this method has more uses than inline method [6].

In this way the first phase is used three series and three feature of neural network is used. For each set of attributes and for each class, a neural network is considered. In the first stage of classification, the results of the neural network decision are combined with Euclidean distance obtained from three feature sets. Classification results of the first stage, is the input of second stage, which is a RBF neural network and the final output is produced. An example of statistical features used is described [7]. Whole feature such as height or the number of pixels of face image area in the picture, the net width: image width by removing the horizontal spaces. Net height: height of the face after removal of the vertical space. Vertical distance between the center and left and right is the scale for direction of faces that Vertical and horizontal centers are calculated in this way.

$$c_y = \frac{\left[\sum (y) \times \sum (b)\right]}{\Sigma\Sigma(b)} \quad (1)$$

$$c_x = \frac{\left[\sum (x) \times \sum (b)\right]}{\Sigma\Sigma(b)} \quad (2)$$

2. FACE RECOGNITION SYSTEM
In a face recognition system, before processing, it is necessary to create a proper database, after creating the bank, the first step in identifying system design, low-level operations, including pre-processing operations such as improved picture images, remove noise, binary and etc. Secondly, features of prepared images and pre-selection process will be identified and extracted. In the third stage, high-level operations and understanding of image by help of the results and the extracted features that can be done in many ways especially classifier is introduced. Methods such as fuzzy classifier, statistical, neural network and etc., in the proposed method three pre-processing, feature extraction and classifier design have been considered. In this paper procedures for each stage to achieve optimal response being used or introduced.

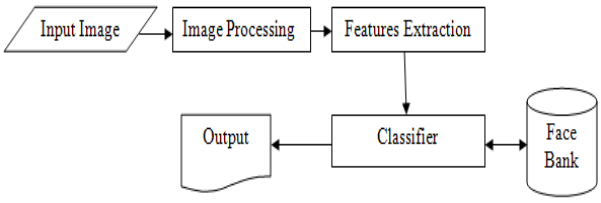

Fig 1: Structure of Face Recognition System

Mainly in image engineering "images are color or gray level or black. In binary images only two gray levels of 0 and 255 are 0 and 1 as normalizing represented. In processing faces, the need to maintain and use color It is therefore to increase the volume of calculations and data processing, binary of images are used. For this to be done it is necessary to obtain a suitable threshold, and two-color image is divided into black and white. Since the background color is white and face has color, to facilitate better working normally "after the binary to make it opposite to the amount of mixed background light intensity = 0 and face become 1. This article has been binary images by helping MATLAB. And the threshold is selected 0.5.

3. STATISTICAL PEROPERTIES

- Ratio of length to width of face sign: The value of this attribute almost "in the face of individual samples is constant and is independent of scale figures.
- Maximum value in the face of the vertical layout: vertical layout, i.e. a binary matrix, each column of the image, has components equal to 1. The maximum value is calculated. That is detectable on the histogram.

$$v_p(i) = \sum p(i, j) \tag{3}$$

- Net width: image width by removing the horizontal spaces
- Net Height: Sign height after removal of the vertical spaces
- Vertical distance between the center and left and right is the scale for direction of face
- Vertical and horizontal centers, which are calculated this way.

$$c_y = \frac{\left[\sum(y) \times \sum(b)\right]}{\Sigma\Sigma(b)} \tag{4}$$

$$c_x = \frac{\left[\sum(x) \times \sum(b)\right]}{\Sigma\Sigma(b)} \tag{5}$$

- Plan maximum horizontal: similar to the maximum vertical design
- Vertical Plan peaks: the histogram corresponding to number of local maximums
- Peaks of horizontal design: similar to peak vertical design
- Whole yaw angle: Image rotated from -30 to 40 degree steps, for each step the number of connections 3 Vertical pixel is calculated.
- Local angles: the angle of rotation for each histogram is calculated vertical design. And 7 amount are summed, represented Angle as a maximum total is Local angles.
- Number of points edges: an edge consists of points that have only a neighbor.
- Total cross points: a cross point of sign, at least has three of the eight neighbors.
- Number of closed loops:

$$c_x = 1 + \frac{\left\lfloor E_k + E_p \right\rfloor}{2} \tag{6}$$

$$E1 = \sum[-2] \tag{7}$$

4. DEFINING PCA AND SPICIFIC IMAGES

Let a binary n * n image with intensity I, in any component of matrix size, with an 8-bit value is shown that the light intensity is pixels. In this case we can consider I a vector of length n2 or a point in n2 dimensional space. Thus an image of 128 * 128 can form a single point in 16,384 dimensional display spaces. Corresponding face images in general, occupy only a small part of this big space, so are not shown as the optimal coordinate system. Methods of specific images work especially with the assumption that the images related to face are a simple form in the space images. Finding optimal coordinate systems for images of human faces, take place through the PCA analysis of the basic components. The optimal coordinate system in this definition is a device that changes the face of the relevant features along the maximum axis [8].

The components of optimized coordinates are perpendicular to each other and as mentioned maximize the variances or changes in the collection of the images. Thus we need methods to evaluate variances in complex images, and this is what we have by special vectors that can be achieved.

Eigen value of I, variance of images available is in axial length represented by a specific vector. So by choosing particular vectors corresponding to the largest Eigen value, we choose the dimensions that represent the largest variances in the pictures.

With particular vectors and obtain the Eigen values we can display face images using only a few coefficients. To obtain these coefficients, it is enough to image a new input image on each of the input vectors to specific image. In this article the numbers of 10,12,15,20 and 25 PCA coefficient vector is used.

5. ZERNIK MOMENTS

It is strongly encouraged that the authors may use SI (International System of Units) units only.

Other features of this paper is a kind of statistical features, is called Zernike moments. Zernike polynomials were presented first in 1934 by Mr. Zernike [9]. This type of torque moments describe the complex moments that is used in classification [10]. Zernike complex moments are of a series of complex polynomial, which made form a basic orthogonal set are on the unit circle.

$$(X2+y2) \leq 1 \tag{8}$$

Two dimensional torques are displayed as Am. m is called the rank and F function or the desired image and n is a number that can be positive or negative expresses dependence, or rotation angle. Following conditions is established in all polynomials.

$$m-|n|=even,|n|\le m \tag{9}$$

$$A_{mn}=A_{m,-n} \tag{10}$$

$$(X2+y2)\le 1 \ \&\ m=0,1\ldots.\infty \tag{11}$$

$$A_{mn}=\frac{m+1}{\pi}\iint_{xy} f(x,y)[V_{mn}(x,y)]\times dxdy \tag{12}$$

Zernike polynomial v is equal to in polar coordinates:

$$V_{mn}(r,\theta)=R_{mn}(r)\exp(jn\theta) \tag{13}$$

The (r, θ) is defined on the unit circle and Rmn(r), j=√-1 radial polynomial is orthogonal. That is defined as the following.

$$R_{mn}(r)=\sum_{x=0}^{m-|n|\div 2}(-1)^x F(m,n,s,r) \tag{14}$$

$$F(m,n,s,r)=\frac{(m-s)!}{s!(\frac{m+|n|}{2-s})!(\frac{m-|n|}{2-s})!}r^{m-2s} \tag{15}$$

$$R_{mn}(r)=R_{m,-n}(r) \quad and \quad Rmn(r)=0 \tag{16}$$

6 Orthogonal Polynomial Are Thus Quantified

$$R00(r)=1,\ R11(r)=r,\ R20(r)=2r2-1,\ R22(r)=r2,$$

$$R31(r)=3r3-2r,\ R33(r)=r3 \tag{17}$$

To calculate Zernike moments, first image is written on polar coordinates on a unit circle, so the center of image is the center of the circle. Pixels that are located outside the circle, are not used in calculations.

As in the result, images are weighted that show its distance to the center. The false-pixel basis in the environment have been around will get more weight than the pixel that are located in the main environment. To calculate the Zernike moments of signature images, moments to the order 6,7,8,9, and 10 were investigated and the moments up to rank 7, 8 have been used. In a study [11] the eighth rank moments are calculated as best rank. To do the necessary calculations, the coding environment of MATLAB Tool-Box named Lans / Pattern Recognition used the same name it can be searched on the Internet.

6. IMPELEMENTATION

After extraction of features and producing feature vectors, vectors derived using neural network classifier RBF, classification and feature vector closest to the input image is chosen as a input image class. In this paper, RBF neural network and learning method FHLA presented in this review taught and then are tested [12]. After finding the class input image, the image with the least distance is the input image will appear as the classifier output.

6.1 Results

Methods for pre-processing and preparation of image feature extraction and production of feature vector elements, training neural network and finally testing the system in previous sections of this article explained, using the MATLAB programming environment implemented on the desired images banks that have been tested. This result will be reviewed in more tests.

Implementation and testing phase on the bank, like other systems, the total images in the database images are divided into two equal parts. 500 Images in Bank Images is used for testing and the other 500 images is used for training. Division is such that each person in the bank has 10th random image as the image is considered training and since there are 50 people in this bank, so 500 images is considered for the training. In image Bank, 10 Image per person, 10 Image as training and the remaining random testing is considered as the order. Experiments conducted in this paper can be prepared in three parts, images preparation, producing feature vectors, and finally the neural network training system test summary. In the first part of preprocessing steps on the whole image database, the second part of the experiments, the desired features of training images are extracted and post-production training feature vectors, the third stage of RBF neural network learning algorithm based on desired, taught in the fourth stage and then using the test images, first desired feature vectors, extracted and then the classifier network RBF, the input image into one of the classes seems attributable trained [13].

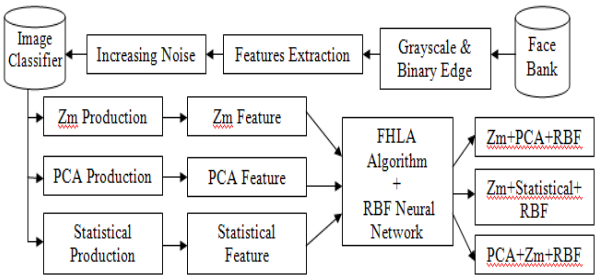

Fig 2: Proposed System Structure

6.2 Rank Torque effect on system performance

In this part of the testing, the feature extraction process, Zernike moments are considered. Tests have been selected in two phases based on the torque selection. In the first stage, up to rank seventh all Moments are considered as feature vector elements. In the second stage, all the moments up to eight times are selected as feature vector elements. The accuracy of the system is measured according to sample tests.

Also it is shown that higher-order moments of ZM have more information "to identify their signatures [14]. This increasing in the rank, is associated with increased time of calculation of the adverse factors are considered in computing speed of the system. To obtain better performance, Effect of torque on the order of time was calculated. And moments up to two times seven and eight were selected. Figure 2 shows the torque effect on the computation time. And Table 1 and 2 in the final results of the tests respectively ZM, PCA, Statistical and their various combinations are shown

Table 1. Results of recognition for composition of PCA, ZM and statistical features

Feature	ZM rank	Number of epoch	FCM optimal repeat for minimizing cost function	Number of input coefficient
Statistical	-	17	3	5
Statistical and Zernike	7	15	3	25
PCA and statistical	-	79	7	17
Zernike and PCA statistical	7	15	3	37

Table 2. Results of recognition for composition of PCA, ZM

Feature	ZM rank	Number of epoch	FCM optimal repeat for minimizing cost function	Number of input coefficient	Error rate
Zernike Moment	7	35	2	20	2.5%
Zernike Moment	8	39	4	25	1%
PCA	-	35	7	12	2.5%
Zernike and PCA	7	46	2	32	1%

6.3 Effect of noise on system performance

Amount of noise in an image is calculated based on image noise density. Noise density equal to the total number of pixels noise image pixels that are expressed as a percentage. In this paper, salt pepper noise in the density values of 1% and 2% applied to the images and results have been evaluated. The result shows that the system against 1% salt and pepper noise value has a favorable conditions and increase to 2 percent for the system noise can tolerate but a higher percentage of it, affect the system performance. And

6.4 Compared Methods

As mentioned in previous sections, given that nationality and language, in the face, has an enormous impact, it is possible for an algorithm proposed by European and American figures, hasn't an appropriate response to Chinese or Japanese. So compared with the figure of algorithms with different nations actually is not possible. According to average error of various different methods was discussed.

Table 3. Comparison of different methods with proposed method

Face Pattern	Kind of Face	Classifier	Kind of Feature	Mean of Recognition Error
Six methods proposed in this paper	to Asian faces of persons	fuzzy neural network	PCA,ZM8	0.5%
			PCA,ZM7	1%
			PCA, ZM, and Statistical	0.5%
			PCA and Statistical	2.5%
			Statistical and ZM	0.5%
			Statistical	2.5%

7. CONCLUSION

According to the results of simulation and implementation of face recognition systems below results can be briefly considered.

- The proposed algorithm on the desired bank, has a very good accuracy, especially in combination of two features and the PCA Rank 8 ZM and combine three features and ZM and PCA and statistical.
- Using the fuzzy algorithm FCM in initialization parameters in hidden layer of RBF neural network training increases speed and because it takes the value appropriate week and is close to optimal parameters.
- Not only in detecting faces, but also to identify other patterns in the identity of individuals to help identify machine vision and image processing can be done from the fuzzy neural network classifier and the proposed algorithm can be used.

Noise pepper salt to 2% hasn't negative impact on system performance and the system can tolerate up to 2% noise.

8. REFERENCES

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